to the client computer(s). The server may also transmit data adapted to cause a client computer to perform a specified function, e.g., to perform a calculation, to display specified data on a screen, etc. For example, the server may transmit a request adapted to cause a client computer to perform one or more of the method steps described herein, including one or more of the steps of FIGS. **8-11**. Certain steps of the methods described herein, including one or more of the steps of FIGS. **8-11**, may be performed by a server or by another processor in a network-based cloud-computing system. Certain steps of the methods described herein, including one or more of the steps of FIGS. **8-11**, may be performed by a client computer in a network-based cloud computing system. The steps of the methods described herein, including one or more of the steps of FIGS. **8-11**, may be performed by a server and/or by a client computer in a network-based cloud computing system, in any combination.

[0075] Systems, apparatus, and methods described herein may be implemented using a computer program product tangibly embodied in an information carrier, e.g., in a non-transitory machine-readable storage device, for execution by a programmable processor; and the method steps described herein, including one or more of the steps of FIGS. **8-11**, may be implemented using one or more computer programs that are executable by such a processor. A computer program is a set of computer program instructions that can be used, directly or indirectly, in a computer to perform a certain activity or bring about a certain result. A computer program can be written in any form of programming language, including compiled or interpreted languages, and it can be deployed in any form, including as a stand-alone program or as a module, component, subroutine, or other unit suitable for use in a computing environment.

[0076] A high-level block diagram **1200** of an example computer that may be used to implement systems, apparatus, and methods described herein is depicted in FIG. **12**. Computer **1202** includes a processor **1204** operatively coupled to a data storage device **1212** and a memory **1210**. Processor **1204** controls the overall operation of computer **1202** by executing computer program instructions that define such operations. The computer program instructions may be stored in data storage device **1212**, or other computer readable medium, and loaded into memory **1210** when execution of the computer program instructions is desired. Thus, the method steps of FIGS. **8-11** can be defined by the computer program instructions stored in memory **1210** and/or data storage device **1212** and controlled by processor **1204** executing the computer program instructions. For example, the computer program instructions can be implemented as computer executable code programmed by one skilled in the art to perform the method steps of FIGS. **8-11** and the modules of FIG. **1**. Accordingly, by executing the computer program instructions, the processor **1204** executes the method steps of FIGS. **8-11** and modules of FIG. **1**. Computer **1204** may also include one or more network interfaces **1206** for communicating with other devices via a network. Computer **1202** may also include one or more input/output devices **1208** that enable user interaction with computer **1202** (e.g., display, keyboard, mouse, speakers, buttons, etc.).

[0077] Processor **1204** may include both general and special purpose microprocessors, and may be the sole processor or one of multiple processors of computer **1202**. Processor **1204** may include one or more central processing units (CPUs), for example. Processor **1204**, data storage device **1212**, and/or memory **1210** may include, be supplemented by, or incorporated in, one or more application-specific integrated circuits (ASICs) and/or one or more field programmable gate arrays (FPGAs).

[0078] Data storage device **1212** and memory **1210** each include a tangible non-transitory computer readable storage medium. Data storage device **1212**, and memory **1210**, may each include high-speed random access memory, such as dynamic random access memory (DRAM), static random access memory (SRAM), double data rate synchronous dynamic random access memory (DDR RAM), or other random access solid state memory devices, and may include non-volatile memory, such as one or more magnetic disk storage devices such as internal hard disks and removable disks, magneto-optical disk storage devices, optical disk storage devices, flash memory devices, semiconductor memory devices, such as erasable programmable read-only memory (EPROM), electrically erasable programmable read-only memory (EEPROM), compact disc read-only memory (CD-ROM), digital versatile disc read-only memory (DVD-ROM) disks, or other non-volatile solid state storage devices.

[0079] Input/output devices **1208** may include peripherals, such as a printer, scanner, display screen, etc. For example, input/output devices **1280** may include a display device such as a cathode ray tube (CRT) or liquid crystal display (LCD) monitor for displaying information to the user, a keyboard, and a pointing device such as a mouse or a trackball by which the user can provide input to computer **1202**.

[0080] Any or all of the systems and apparatus discussed herein, including elements of workstation **102**, image acquisition device **106**, and navigation system **110** of FIG. **1**, may be implemented using one or more computers such as computer **1202**.

[0081] One skilled in the art will recognize that an implementation of an actual computer or computer system may have other structures and may contain other components as well, and that FIG. **12** is a high level representation of some of the components of such a computer for illustrative purposes.

[0082] The foregoing Detailed Description is to be understood as being in every respect illustrative and exemplary, but not restrictive, and the scope of the invention disclosed herein is not to be determined from the Detailed Description, but rather from the claims as interpreted according to the full breadth permitted by the patent laws. It is to be understood that the embodiments shown and described herein are only illustrative of the principles of the present invention and that various modifications may be implemented by those skilled in the art without departing from the scope and spirit of the invention. Those skilled in the art could implement various other feature combinations without departing from the scope and spirit of the invention.

1. A method for image registration, comprising:

extracting personalized biomechanical parameters from a first region of tissue of a patient in an inverse problem of the biomechanical model using pre-operative imaging data and intra-operative imaging data;

identifying correspondences between an outer layer of a second region of the tissue in the pre-operative imaging data and the outer layer of the second region of the tissue in the intra-operative imaging data; and